What is claimed is:

1. A method for improving the efficiency of exchanging a first fluid within a gel by a second fluid comprising applying pulses of pressure having at least one frequency to the gel, the first fluid and the second fluid during the exchange.

2. The method of Claim 1, wherein the first fluid is a solvent liquid used to prepare the gel.

3. The method of Claim 1, wherein the second fluid is a supercritical fluid.

4. The method of Claim 1, wherein the pulses have a frequency of about 1 to 100,000 Hz and an amplitude of about 0.1 to 20 psi.

5. The method of Claim 1, wherein the pulses have a frequency of about 2,000 to 50,000 Hz and an amplitude about 0.3 to 5 psi.

6. The method of Claim 1, wherein the pulses have a frequency of about 0.0001 to about 10 Hz and an amplitude of about 10 to 1,000 psi.

7. The method of Claim 1, wherein the pulses have a frequency in the range of about 0.001 to about 1 Hz and an amplitude about 100 to 600 psi;

8. The method of Claim 1, wherein the first fluid is selected from the group consisting of liquid, gas, and supercritical fluid and the second fluid is selected from the group consisting of liquid, gas, and supercritical fluid.

9. The process of Claim 1, wherein the gel is an inorganic gel.

10. The process of Claim 9, wherein the inorganic gel is an oxides of a metal selected from the group consisting of silicon, aluminum, iron, copper, zirconium,

hafnium, magnesium, yttrium, and mixtures thereof.

11. The process of Claim 1, wherein the gel is an organic gel.

12. The process of Claim 11, wherein the organic gel is selected from the group consisting of polyacrylate, polystyrene, polyacrylonitrile, polyurethane, polyimide, polyfurfural alcohol, phenol furfuryl alcohol, polyfurfuryl alcohol, melamine-formaldehyde resin, resorcinol-formaldehyde resin, cresol formaldehyde resin, phenol-formaldehyde resin, polyvinyl alcohol dialdehyde, polycyanurate, polyacrylamide, epoxy resin, agar, and mixtures thereof.

13. The method of Claim 1, wherein the first fluid is a solvent liquid used to prepare the gel and the second fluid is a supercritical fluid.

14. The method of Claim 1, wherein the first fluid is a supercritical fluid and the second fluid is a non-reacting, non-condensible gas.

15. The method of Claim 14, wherein the inert non-reacting non-condensible gas is selected from the group consisting of air, nitrogen, oxygen, helium, neon, argon, hydrogen, and mixtures thereof.

16. The method of Claim 1, wherein the first fluid is a supercritical fluid and the second fluid is a gas.

17. The method of Claim 1, wherein the first fluid is a liquid and the second fluid is a liquid.

18. The method of Claim 1, wherein the gel is an inorganic gel prepared by the hydrolysis and condensation of a metal alkoxide.

19. The method of Claim 18, wherein the metal alkoxide has about 1 to 6

carbon atoms in each alkyl group.

20. The method of Claim 18, wherein the metal alkoxide is selected from the group consisting of tetra-ethoxysilane (TEOS), tetramethoxysilane (TMOS), tetra-n-propoxysilane, aluminum isopropoxide, aluminum sec-butoxide, cerium isopropoxide, hafnium tert-butoxide, magnesium aluminum isopropoxide, yttrium isopropoxide, zirconium isopropoxide, and mixtures thereof.

21. The method of Claim 1 wherein the pulses are generated by one or more of a piezoelectric device, an electromechanical device, a mechanical device, liquid piston, a piston, a diaphragm, an inflatable device, audio frequency speakers, mechanical tapping, vibrating table, and a variation in the pressure or the back pressure of a fluid or a flowing gas.

22. A method for reducing the time required to exchange a solvent liquid located within a gel with a supercritical extracting fluid in a means for performing the exchange during the preparation of an aerogel, comprising providing the solvent liquid within the gel at a temperature no more than 10°C below the critical temperature of the supercritical fluid before the supercritical fluid contacts the solvent liquid.

23. The method of Claim 22, wherein the means for performing the exchange, the supercritical extracting fluid, and any excess solvent liquid required to prevent drying, are at a temperature no more than 10°C below the critical temperature.

24. The method of Claim 22, further comprising applying pressure pulses of at least one frequency to the gel, the solvent liquid and the supercritical extracting fluid during the exchange.

25. The method of Claim 24, comprising applying pressure pulses of two different frequencies.

26. The method of Claim 25, wherein the two different frequencies are a first frequency of about 1 to about 100,000 Hz and a second frequency of about 0.0001 to about 10 Hz. and the second frequency is lower that the first frequency.

27. The method of Claim 26, wherein the pulses of the first frequency have an amplitude of about 0.1 to 20 psi and the pulses of the second frequency have an amplitude of about 10 to 1,000 psi and the amplitude at the second frequency is higher than the amplitude of the first frequency.

28. The method of Claim 24, wherein the pulses are generated by one or more of a piezoelectric device, an electromechanical device, a mechanical device, liquid piston, a piston, a diaphragm, an inflatable device, audio frequency speakers, mechanical tapping, vibrating table, and a variation in the pressure or the back pressure of a fluid or a flowing gas.

29. A method for rapid depressurization of a supercritical fluid within and around a porous medium, the method comprising exchanging the supercritical fluid with a non-reacting, non-condensing gas before or during the depressurization.

30. The method of Claim 29, wherein the porous medium is an aerogel.

31. The method of Claim 29, further comprising applying pulses of pressure during said exchange.

32. The method of Claim 31, comprising applying pulses of two different frequencies.

33. The method of Claim 32, wherein the two different frequencies are a first frequency of about 1 to about 100,000 Hz and a second frequency of about 0.0001 to about 10 Hz. and the second frequency is lower that the first frequency.

34. The method of Claim 33, wherein the pulses of the first frequency have an amplitude of about 0.1 to 20 psi and the pulses of the second frequency have an amplitude of about 10 to 1,000 psi, and the amplitude at the second frequency is higher than the amplitude of the first frequency.

35. The method of Claim 32, wherein at least one of the two different frequencies is systematically varied during the depressurization.

36. The method of Claim 31, wherein the pulses are generated by one or more of a piezoelectric device, an electromechanical device, a mechanical device, liquid piston, a piston, a diaphragm, an inflatable device, audio frequency speakers, mechanical tapping, vibrating table, and a variation in the pressure or the back pressure of a fluid or a flowing gas.

37. A method for rapid depressurization of a supercritical fluid within a porous medium in a device, the method comprising supplying heat into the device through injection of a heated supercritical fluid down to just below its critical pressure and thereafter injection of a heated gas down to about atmospheric pressure.

38. The method of Claim 37, wherein the porous medium is an aerogel.

39. The method of Claim 37, further comprising applying pulses of pressure during said exchange.

40. The method of Claim 39, comprising applying pressure pulses of two different frequencies.

41. A method of preparing an aerogel comprising the steps of: (i) placing in an extractor at atmospheric pressure wet gels having pores and containing a solvent liquid in the pores and around the wet gels, (ii) raising the temperature of the extractor, (iii) adding carbon dioxide at substantially the same temperature as that of the extractor,

(iv) gradually increasing the pressure in the extractor so as to form supercritical carbon dioxide in said extractor, wherein the rate of increase of pressure or of temperature is sufficiently low that it does not adversely affect the properties or integrity of the gel.

42. A method of exchanging the solvent liquid in a wet gel with a supercritical fluid to form an aerogel, the method comprising: providing an extractor containing the wet gel having a porous structure, said gel containing within its pores a solvent liquid; providing a supercritical fluid in the extractor in contact with and in approximate equilibrium of pressure and temperature with the solvent liquid-containing wet gels; and applying pulses of pressure to said supercritical fluid, thereby accelerating the mixing of the supercritical carbon dioxide and the solvent liquid.

43. A method for decreasing the time required for preparing an aerogel in an extractor wherein the aerogel is filled with a supercritical fluid, the method comprising exchanging the supercritical fluid with a non-reacting non-supercritical gas, followed by depressurization.

44. The method of Claim 43, wherein the inert non-reacting non-supercritical gas is selected from air, nitrogen, oxygen, helium, neon, argon, hydrogen, and mixtures thereof.

45. The method of Claim 43, wherein the gas exchange is accelerated by applying pulses of pressure to the non-reacting non-supercritical gas phase.

46. The method of Claim 44, wherein two sets of pulses are applied to said supercritical fluid, wherein a first set of pulses has frequencies of about 1Hz to 100,000 Hz, and the second set of pulses has frequencies in the range of about 0.001 to 10 Hz, and the second frequency is lower that the first frequency.

47. An improved method of exchanging the solvent in wet gels for a supercritical fluid, the method comprising:

providing an extractor containing wet gels, said wet gels containing in their pores a solvent liquid, and further containing a supercritical fluid in contact with, and in approximate equilibrium of pressure and temperature with, said solvent-containing wet gels;

wherein each of the solvent liquid, the wet gels, the extractor, and the gas, liquid, and supercritical phases of the extracting supercritical fluid are maintained above the critical temperature of the supercritical fluid from the beginning of the introduction of the extracting fluid into the extractor, until the solvent is extracted from the gel.